FOUNDATIONS OF EDUCATIONAL THEORY FOR ONLINE LEARNING

Mohamed Ally

Athabasca University

INTRODUCTION

There is ongoing debate about whether using a particular delivery technology improves the learning (Beynon, 2007; Clark, 2001; Kozma,

2001). It has long been recognized that specialized delivery technologies can provide efficient and timely access to learning materials; however, Clark (1983) claims that technologies are merely vehicles that deliver instruction, and do not themselves influence student achievement. As Clark notes, meta-analysis studies on media research show that students gain significant learning benefits from audiovisual or computer media, as opposed to conventional instruction; however, the same studies also suggest that the reason for those benefits is not the medium of instruction, but the instructional strategies built into the learning materials. Similarly, Schramm (1977) suggests that learning is influenced more by the content and instructional strategy in the learning materials than by the type of technology used to deliver instruction.

According to Bonk and Reynolds (1997), to promote higher-order thinking on the Web, online learning must create challenging activities that enable learners to link new information to old; acquire meaningful knowledge; and use their metacognitive abilities; hence, it is the instructional strategy, not the technology, that influences the quality of learning. Kozma (2001), on the other hand, argues that the particular attributes of the computer are needed to bring real-life models and simulations to the learner; thus, according to Kozma, the medium does influence learning. Kozma claims that it is not the computer per se that makes students learn, but the design of the real-life models and simulations, and the students' interaction with those models and simulations. The computer is merely the vehicle that provides the processing capability and delivers the instruction to learners (Clark, 2001).

Online learning allows participants to collapse time and space (Cole, 2000); however, the learning materials must be designed properly to engage the learner and promote learning. The delivery method allows for flexibility of access, from anywhere and usually anytime, but the learning must use sound instructional design principles. According to Rossett (2002), online learning has many promises, but it takes commitment and resources, and must be done right. Doing it right means that online learning materials must be designed properly, with the learners and learning in focus, and that adequate support must be provided. Ring and Mathieux (2002) suggest that online learning should have high authenticity (i.e., students should learn in the context of the work place), high interactivity, and high collaboration. This chapter discusses the foundation of educational theory for the design of effective online learning materials, and suggests a model for developing online instruction based on appropriate educational theory.

Different terminologies have been used for online learning, which makes it difficult to develop a generic definition. Terms commonly used for online learning include e-learning, Internet learning, distributed learning, networked learning, tele-learning, virtual learning, computer-assisted learning, web-based learning, and distance learning. All of these terms imply that the learner is at a distance from the tutor or instructor, that the learner uses some form of technology (usually a computer) to access the learning materials, that the learner uses technology to interact with the tutor or instructor and with other learners, and that some form of support is provided to learners. This paper will use the term online learning throughout. There are many definitions of online learning in the literature, reflecting the diversity of practice and associated technologies.

Carliner (1999) defines online learning as educational material that is presented on a computer. Khan (1997) defines online instruction as an innovative approach for delivering instruction to a remote audience, using the Web as the medium. Online learning, however, involves more than just the presentation and delivery of materials using the Web: the learner and the learning process should be the focus of online learning. As a result, the author defines online learning as

[t]he use of the Internet to access learning materials; to interact with the content, instructor, and other learners; and to obtain support during the learning process, in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience. (Ally, p. 7)

BENEFITS OF ONLINE LEARNING

Increasingly, organizations are adopting online learning as the main delivery method to train employees (Simmons, 2002). At the same time, educational institutions are moving toward the use of the Internet for delivery, both on campus and at a distance. For organizations and institutions to make this often expensive move, there must be a perception that using online learning provides major benefits. Some of the benefits for learners and instructors are detailed below.

For learners, online learning knows no time zones, and location and distance are not issues. In asynchronous online learning, students can access the online materials anytime, while synchronous online learning allows for real-time interaction between

students and instructors. Learners can use the Internet to access up-to-date and relevant learning materials, and can communicate with experts in the field which they are studying. Situated learning, or the application of knowledge and skills in specific contexts, is facilitated, since learners can complete online courses while working on the job or in their own space, and can contextualize the learning.

For instructors, tutoring can be done anytime, anywhere. Online materials can be updated, and learners can see the changes immediately. When learners are able to access materials on the Internet, it is easier for instructors to direct them to appropriate information based on their needs. If designed properly, online learning systems can be used to determine learners' needs and current level of expertise, and to assign appropriate materials for learners to select from, to achieve their desired learning outcomes.

DESIGNING ONLINE LEARNING MATERIALS

The goal of any instructional system is to promote learning. Therefore, before any learning materials are developed, educators must tacitly or explicitly know the principles of learning and how students learn. This is especially true for online learning, where instructors and learners are separated. The development of effective online learning materials should be based on proven and sound learning theories. As discussed above, the delivery medium is not the determining factor in the quality of learning per se; rather, course design determines the effectiveness of the learning (Rovai, 2002).

There are many schools of thought on learning, and no one school is used exclusively to design online learning materials. As there is no single learning theory to follow, we can use a combination of theories to develop online learning materials. In addition, as research progresses, new theories that should be used are emerging and evolving. A recent example is connectivist theory, which is needed for the emerging age of distributed and network learning. Some may question the need for a new learning theory, however, especially when there are already well-established theories used successfully to design instruction. Also, past learning theories have been adapted to address new and changing learning contexts. These existing learning theories, however, were developed before distributed and networked learning was used widely by educators. According to Siemens (2004), we now need a theory for the digital age to guide the development of learning materials for the net worked world. Educators should be able to adapt existing learning theories for the digital age, while at the same time using the principles of connectivism to guide the development of effective learning materials. What is needed is not a new stand-alone theory for the digital age, but a model that integrates the different theories to guide the design of online learning materials.

To select the most appropriate instructional strategies, the online developer must know the different approaches to learning. Strategies should be selected to motivate learners, facilitate deep processing, build the whole person, cater to individual differences, promote meaningful learning, encourage interaction, provide relevant feedback, facilitate contextual learning, and provide support during the learning process. The remaining sections of this chapter present the different schools of thought on learning and suggest how these different schools of thought can be used to develop effective online materials.

SCHOOLS OF LEARNING

Early computer learning systems were designed based on a behaviorist approach to learning. The behaviorist school of thought, influenced by Thorndike (1913), Pavlov (1927), and Skinner (1974), postulates that learning is a change in observable behaviour caused by external stimuli in the environment (Skinner, 1974). Behaviorists claim that observable behaviour indicates whether or not the learner has learned something, and not what is going on in the learner's head. In response, some educators claim that

not all learning is observable and there is more to learning than a change in behaviour. As a result, there has been a shift away from behaviorist to cognitive learning theories.

Cognitive psychology claims that learning involves the use of memory, motivation, and thinking, and that reflection plays an important part in learning. Cognitive theorists see learning as an internal process, and contend that the amount learned depends on the processing capacity of the learner, the amount of effort expended during the learning process, the depth of the processing (Craik & Lockhart, 1972; Craik & Tulving,1975), and the learner's existing knowledge structure (Ausubel, 1974).

Recently, there has been a move towards constructivism. Constructivist theorists claim that learners interpret the information and the world according to their personal reality, that they learn by observation, processing, and interpretation, and then personalize the information into personal knowledge (Cooper, 1993; Wilson, 1997). Learners learn best when they can contextualize what they learn for immediate application and personal meaning.

A recently proposed theory under discussion is connectivism (Downes, 2006; Siemens, 2004). According to Siemens, connectivism is the integration of principles explored by chaos, network, complexity and self-organization theories. Due to the information explosion in the current age, learning is not under the control of the learner. Changing environments, innovations, changes in the discipline and in related disciplines all suggest that learners have to unlearn what they have learned in the past, and learn how to learn and evaluate new information. What must be learned is determined by others and is continually changing. And since machines are becoming smart with the use of intelligent agents, Siemens also asks whether, in fact, learning may reside in machines. Some knowledge will reside in machines while some will reside in humans. The challenge for educators, therefore, is how to design instruction for both machines and humans, and how the two can interact with each other. For example, if there is a change in a procedure on how to use a machine, the wireless capability in the machine will allow the updated procedure to be downloaded into the machine's memory. When a learner goes to interact with the recently updated machine, that learner will be informed that the procedure has changed and that the machine will guide them through the procedure (Siemens 2004).

Under a close analysis of the behaviorist, cognitivist, and constructivist schools of thought, many overlaps in the ideas and principles become apparent. The design of online learning materials can include principles from all three schools of thought. According to Ertmer and Newby (1993), the three schools of thought can, in fact, be used as a taxonomy for learning. Behaviorists' strategies can be used to teach the what (facts); cognitive strategies can be used to teach the how (processes and principles); and constructivist strategies can be used to teach the why (higher-level thinking that promotes personal meaning, and situated and contextual learning). Janicki and Liegle (2001) analyzed different instructional design models to identify the components that support quality design of web-based instruction. They identify components from each of the behaviorist, cognitivist, and constructivist schools of learning, and explore connectivist theory to help designers use it to guide the design of learning materials.

Behaviorist School of Learning

The behaviorist school sees the mind as a black box, in the sense that a response to a stimulus can be observed quantitatively, thereby ignoring the effect of thought processes occurring in the mind. This school, there fore, looks at overt behaviours that can be observed and measured as indicators of learning (Good & Brophy, 1990).

Implications for Online Learning

1. Learners should be told the explicit outcomes of the learning so they can set expectations and judge for themselves whether or not they have achieved the outcome of the online lesson.

2. Learners must be tested to determine whether or not they have achieved the learning outcome. Online testing or other forms of testing and assessment should be integrated into the learning sequence to check individual learner's achievement level and provide appropriate feedback.

3. The learning materials must be sequenced appropriately to promote learning. The sequencing could take the form of simple to complex, known to unknown, and knowledge to application.

4. Learners must be provided with feedback so that they can monitor how they are doing and take corrective action if required.

COGNITIVIST SCHOOL OF LEARNING

Cognitivists see learning as an internal process that involves memory, thinking, reflection, abstraction, motivation, and metacognition. Cognitive psychology looks at learning from an information processing point of view, where the learner uses different types of memory during learning (Figure 1). Sensations are received through the senses into the

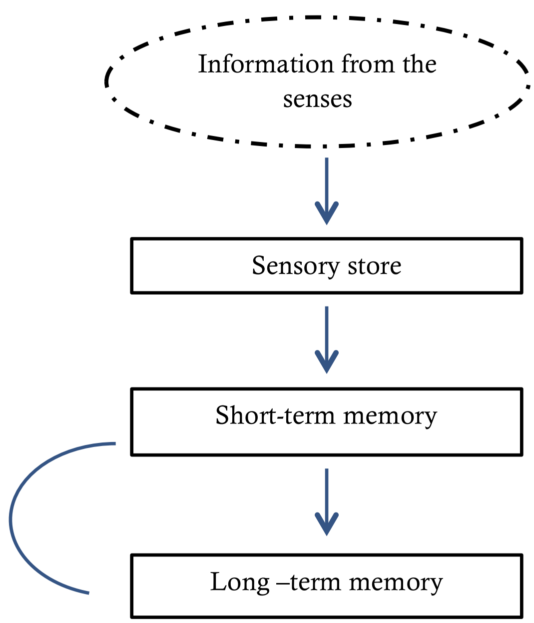


Figure 1. Types of memory

sensory store before processing occurs. The information persists in the sensory store for less than one second (Kalat, 2007), and if it is not transferred to working memory immediately, it is lost. Online instruction must use strategies to allow learners to attend to the learning materials so they can be transferred from the senses to the sensory store and then to working memory. The amount of information transferred to working memory depends on the amount of attention that was paid to the incoming information and whether cognitive structures are in place to make sense of the information. The duration in working memory is approximately 20 seconds, and if information in working memory is not processed efficiently, it is not transferred to long-term memory for storage (Kalat, 2007). So, designers must check to see if the appropriate existing cognitive structure is present to enable the learner to process the information. If the relevant cognitive structure is not present, pre-instructional strategies, such as advance organizers, should be included as part of the learning process (Ausubel, 1960).

Online learning strategies must present the materials and use strategies that enable students to process the materials efficiently. Since working memory has limited capacity, information should be organized or chunked in pieces of appropriate size to facilitate processing. According to Miller (1956), because humans have limited short-term memory capacity, information should be grouped into meaningful sequences, such as five to nine (i.e., 7 ±2), meaningful units.

After the information is processed in working memory, it is stored in long-term memory. The amount transferred to long-term memory is determined by the quality and depth of processing in working memory. The deeper the processing, the more associations the acquired new information forms in memory. Information transferred from short-term memory to long-term memory is either assimilated or accommodated in long-term memory. During assimilation, the information is changed to fit into existing cognitive structures. Accommodation occurs when an existing cognitive structure is changed to incorporate the new information.

Cognitive psychology postulates that information is stored in long term memory in the form of nodes which connect to form relationships; that is, in networks. So, information maps that show the major concepts in a topic, and the relationships between those concepts, should be included in the online learning materials. According to Stoyanova and Kommers (2002), information-map generation requires critical reflection and is a method for externalizing the cognitive structure of learners. To facilitate deeper processing, learners should be encouraged to generate their own information maps.

Implications for Online Learning

1. Strategies used should allow learners to perceive and attend to the information so that it can be transferred to working memory. Learners use their sensory systems to register the information in the form of sensations. Strategies to facilitate maximum sensation should be used. Examples include the proper location of the information on the screen, the attributes of the screen (e.g., colour, graphics, size of text), the pacing of the information, and the mode of delivery (audio, visuals, animations, or video). Learners must receive the information in the form of sensations before perception and processing can occur; however, the learner must not be overloaded with sensations, which could be counter productive to the learning process. Non-essential sensations should be avoided, to allow learners to attend to the important information. Strategies to promote perception and attention for online learning include the following:

• Important information should be placed in the centre of the screen for reading, and learners must be able to read from left to right.

• Information critical for learning should be highlighted to focus learners' attention. For example, in an online lesson, headings should be used to organize the details, and format ted to allow learners to attend to and process the information they contain.

• Learners should be told why they should take the lesson, so that they can attend to the information throughout the lesson.

• The difficulty level of the material must match the cognitive level of the learner, so that the learner can both attend to and relate to the material. Links to both simpler and more complicated materials can be used to accommodate learners at different knowledge levels.

2. Strategies used should allow learners to retrieve existing information from long-term memory to help make sense of the new information. Learners must construct a memory link between the new information and some related information already stored in long term memory. Strategies to facilitate the use of existing schema are the following:

• Use advance organizers to activate existing cognitive structure or to provide the information to incorporate the details of the lesson. A comparative advance organizer can be used to help learners recall prior knowledge to help in processing, and an expository advance organizer can be used to help incorporate the details of the lesson (Ausubel, 1960). Mayer (1979) con ducted a meta-analysis of advance organizer studies, and found that these strategies are effective when students are learning from text that is presented in an unfamiliar form. Since most courses contain materials that are new to learners, advance organizers should be used to provide the framework for learning.

• Provide conceptual models that learners can use to retrieve existing mental models or to store the structure they will need to use to learn the details of the lesson.

• Use pre-instructional questions to set expectations and to activate the learners' existing knowledge structure. Questions presented before the lesson facilitate the recall of existing knowledge, help learners to learn the materials, and motivate them to find additional resources to achieve the lesson outcome.

• Use prerequisite test questions to activate the prerequisite knowledge structure required for learning the new materials. With the flexibility of online learning, students with diverse background and knowledge can choose the most appropriate path to review previous or prerequisite learning before new information is presented.

3. Information should be chunked to prevent overload during processing in working memory (Miller, 1956). To facilitate efficient processing in working memory, online learning materials should present between five and nine items on a screen. If there are many items in a lesson, their organization should be shown in the form of information maps. A generalized information map is provided as an overview for the online lesson, and can be linear, hierarchical, or spider-shaped, as illustrated in Figures 2 to 4 (Holley, Dansereau, McDonald, Garland, & Collins 1979; Smith

& Ragan, 1999). As the lesson progresses, each item in the gen eralized information map is presented and broken down into sub-items. At the end of the lesson, the generalized map is shown again, but with the relationships among the items illustrated.

To facilitate deep processing, learners should be asked to generate the information maps during the learning process or as

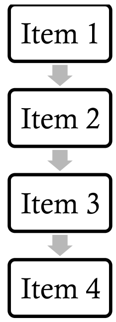


Figure 2. Linear information map

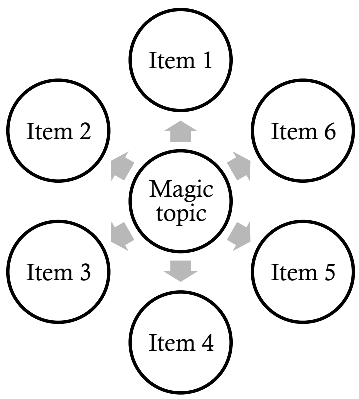


Figure 3. Spider-shaped information map

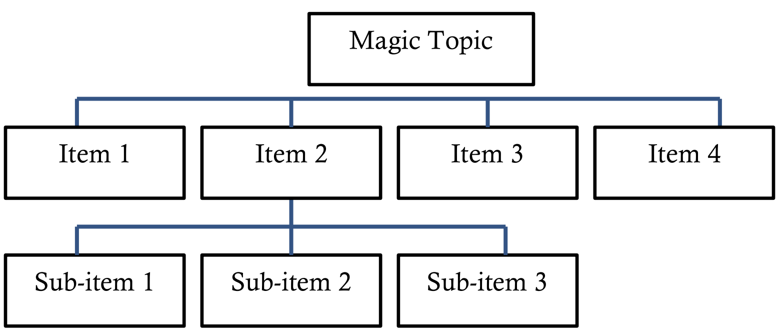


Figure 4. Hierarchical information map

a summary activity after the lesson (Bonk & Reynolds, 1997). In addition to facilitating deep processing, information maps can provide the big picture, to help learners to comprehend the details of a lesson. Online learning can capitalize on the process ing and visual capabilities of the computer to present information maps to learners, or to ask learners to generate information maps using map-making software.

4. Other strategies that promote deep processing should be used to help transfer information to long-term storage. To make the trans fer to long-term memory more effective, strategies should be used that require learners to apply, analyze, synthesize, and evaluate promote higher-level learning. Online strategies to allow learners to apply the information in real life should also be included, to contextualize the learning and to facilitate deep processing.

5. A variety of learning strategies should be included in online instruction to accommodate individual differences and learning styles (Cassidy, 2004). Learning style refers to how a learner perceives, interacts with, and responds to the learning environment; it measures individual differences. Different learning style instruments are used to determine students' learning styles. The Kolb Learning Style Inventory (LSI) looks at how learners perceive and process information (Kolb, 1984), whereas the Myers-Briggs Type Indicator uses dichotomous scales to measure extroversion versus introversion, sensing versus intuition, thinking versus feeling, and judging versus perception (Myers, 1978). In the following discussion, we consider the Kolb Learning Style Inventory.

Kolb suggests that two components make up our learning experience: perceiving and processing. Perceiving refers to the way learners sense and absorb the information around them, from concrete experience to reflective observation. Concrete experience relates to learners' desire to learn things that have personal meaning. During reflective observation, learners like to take the time to think about and reflect on the learning materials. The second component, processing, refers to how learners understand and process the information that is absorbed after perceiving. Processing ranges from abstract conceptualization to active experimentation. Learners who have a preference for abstract conceptualization like to learn facts and figures and research new information on different topics. Learners who have a preference for active experimentation like to apply what they learn to real-life situations and to go beyond what was presented. They like to try things and learn from their experience. Online learning can cater for individual differences by determining a learner's preference and providing appropriate learning activities based on that learner's style.

Online learning materials should include activities for the different styles, so that learners can select appropriate activities based on their preferred learning style. Concrete-experience learners prefer specific examples in which they can be involved, and they relate to peers more than to people in authority. They like group work and peer feedback, and they see the instructor as a coach or helper. These learners prefer support methods that allow them to interact with peers and obtain coaching from the instructor. Reflective-observation learners like to observe carefully before taking any action. They prefer that all the information be available for learning, and see the instructor as the expert. They tend to avoid interaction with others. Abstract-conceptualization learners like to work more with things and symbols and less with people. They like to work with theory and to conduct systematic analyses. Active-experimentation learners prefer to learn by doing practical projects and participating in group discussions. They prefer active learning methods and interact with peers for feedback and information. They tend to establish their own criteria for evaluating situations. Adequate supports should be provided for students with different learning styles. Ally and Fahy (2002) found that students with different learning styles have different preferences for support. For example, the assimilator learning style prefers high instructor presence, while the accommodator learning style prefers low instructor presence.

Cognitive style refers to a learner's preferred way of processing information; that is, the person's typical mode of thinking, remembering, or problem solving. Thus, cognitive style is another individual difference indicator. Cognitive style is considered to be a personality dimension that influences attitudes, values, and social interaction. One of the dimensions of cognitive style that has implications for online learning is the distinction between field dependent and field-independent personalities (Witkin, Moore, Goodenough, & Cox, 1977). Field-independent personalities approach the environment in an analytical manner; for example, they distinguish figures as discrete from their backgrounds.

Field-independent individuals experience events in a more global, less differentiated way. Field-dependent individuals have a greater social orientation compared to field-independent personalities. Field-independent individuals are likely to learn more effectively under conditions of intrinsic motivation, such as self-study, and are influenced less by social reinforcement.

6. Information should be presented in different modes to facilitate processing and transferring it to long-term memory. Where possible, textual, verbal, and visual information should be presented to encourage encoding. According to dual-coding theory (Paivio, 1986), information received in different modes (textual and visual) will be processed better than that presented in a single mode (text). Dual-coded information is processed in different parts of the brain, resulting in more encoding. Presenting information in different modes also accommodates individual differences in processing.

7. Learners should be motivated to learn. It does not matter how effective the online materials are, if learners are not motivated, they will not learn. The issue is whether to use intrinsic motivation (driven from within the learner) or extrinsic motivation (instructor and performance-driven). Designers of online learning materials should use intrinsic motivation strategies to motivate learners (Malone, 1981); however, extrinsic motivation should also be used since some learners are motivated by externally driven methods. Keller proposes the ARCS model (Attention, Relevance, Confidence, Satisfaction) for motivating learners during learning (Keller, 1983; Keller & Suzuki, 1988):

• Attention: Capture the learners' attention at the start of the lesson and maintain it throughout the lesson. The online learning materials must include an activity at the start of the learning session to connect with the learners.

• Relevance: Inform learners of the importance of the lesson and how taking the lesson could benefit them. Strategies could include describing how learners will benefit from taking the lesson, and how they can use what they learn in real-life situations. This strategy helps to contextualize the learning and make it more meaningful, thereby maintaining learners' interest throughout the learning session.

• Confidence: Use strategies such as designing for success and informing learners of the lesson expectations. Design for success by sequencing from simple to complex, or from known to unknown, and use a competency-based approach where learners are given the opportunity to use different strategies to complete the lesson. Inform learners of the lesson outcome and provide ongoing encouragement to complete the lesson.

• Satisfaction: Provide feedback on learners' performance and allow them to apply what they learn in real-life situations.

Learners like to know how they are doing, and they like to contextualize what they are learning by applying the information in real life.

8. Encourage learners to use their metacognitive skills to help in the learning process (Mayer, 1998; Sternberg, 1998; Yorke & Knight, 2004). Metacognition is a learner's ability to be aware of his or her cognitive capabilities and use these capabilities to learn. When learning online, learners should be given the opportunity to reflect on what they are learning, collaborate with other learners, and check their progress. Self-check questions and exercises with feedback throughout a lesson are good strategies to allow learners to check how they are doing, so they can use their metacognitive skills to adjust their learning approach if necessary.

9. Online strategies that facilitate the transfer of learning should be used to encourage application in different and real-life situations. Simulation of the real situation, using real-life cases, should be part of the lesson. Also, learners should be given the opportunity to complete assignments and projects that use real-life applications and information. Transfer to real-life situations could assist the learners to develop personal meaning and contextualize the information.

Cognitive psychology suggests that learners receive and process information to be transferred into long-term memory for storage. The amount of information processed depends on the amount that is perceived, and the amount stored in long-term memory depends on the quality of the processing in working memory. Effective online lessons must use techniques to allow learners to sense and perceive the information, and must include strategies to facilitate high-level processing for transfer of information to long-term memory. After learners acquire the information, they create personal knowledge to make the materials meaningful. The constructivist school of learning, which is discussed below, suggests that learners construct personal knowledge from the learning experience.

CONSTRUCTIVIST SCHOOL OF LEARNING

Constructivists see learners as active rather than passive. Knowledge is not received from the outside or from someone else; rather, the individual learner interprets and processes what is received through the senses to create knowledge. The learner is the centre of the learning, with the instructor playing an advising and facilitating role. Learners should be allowed to construct knowledge rather than being given knowl edge through instruction (Duffy & Cunningham, 1996). The construction of knowledge includes both physical and intellectual learning activities (Phillips, 2005). A major emphasis of constructivists is situated learning, which sees learning as contextual (Hung, Looi, & Koh, 2004). Learning activities that allow learners to contextualize the information should be used in online instruction. If the information has to be applied in many contexts, then learning strategies that promote multi-contextual learning should be used to make sure that learners can indeed apply the information broadly. Learning is moving away from one-way instruction to construction and discovery of knowledge (Tapscott, 1998).

In his transformation theory, Mezirow (1991) uses both constructivism and cognitivism to explain how people learn. He sees learning as "the process of using a prior interpretation to construe a new or revised interpretation of the meaning of one's experience in order to guide future action" (p. 12). Transformative learning involves "reflectively transforming the beliefs, attitudes, opinions, and emotional reactions that constitute our meaning schemes or transforming our meaning perspectives" (p. 223). Mezirow claims that learning involves five interacting contexts: the frame of reference or meaning perspective in which the learning is embedded; the conditions of communication; the line of action (process) in which the learning occurs; the self-image of the learner; and the situation encountered during the learning process (p. 13).

Implications for Online Learning

1. Learning should be an active process. Keeping learners active doing meaningful activities results in high-level processing, which facilitates the creation of personalized meaning. Asking learners to apply the information in a practical situation is an active process, and facilitates personal interpretation and relevance.

2. Learners should construct their own knowledge, rather than accepting that given by the instructor. Knowledge construction is facilitated by good interactive online instruction, since the students have to take the initiative to learn and to interact with other students and the instructor, and because the learning agenda is controlled by the student (Murphy & Cifuentes, 2001). In an online environment, students experience the information first-hand, rather than receiving filtered information from an instructor whose style or background may differ from theirs. In a traditional lecture, instructors contextualize and personalize the information to meet their own needs, which may not be appropriate for all learners. In online instruction, learners experience the information first-hand, which gives them the opportunity to contextualize and personalize the information themselves.

3. Collaborative and cooperative learning should be encouraged to facilitate constructivist learning (Hooper & Hannafin, 1991; Johnson & Johnson, 1996; Palloff & Pratt, 1999). Working with other learners gives learners real-life experience of working in a group and allows them to use their metacognitive skills. Learners will also be able to use the strengths of other learners, and learn from others. When assigning group work, membership should be based on the expertise level and learning style of individual group members, so that individual team members can benefit from one another's strengths.

4. Learners should be given control of the learning process. There should be a form of guided discovery where learners are allowed to made decisions about learning goals, with some guidance from the instructor.

5. Learners should be given time and the opportunity to reflect. When learning online, students need the time to reflect and internalize the information. Embedded questions about the content can be used throughout the lesson to encourage learners to reflect on and process the information in a relevant and meaningful manner; or learners can be asked to generate a learning journal during the learning process, to encourage reflection and processing.

6. Learning should be made meaningful. Learning materials should include examples that relate to the learners so that they can make sense of the information. Assignments and projects should allow learners to choose meaningful activities to help them apply and personalize the information.

7. Learning should be interactive to promote higher-level learning and social presence, and to help develop personal meaning. According to Heinich, Molenda, Russell, and Smaldino (2002), learning is the development of new knowledge, skills, and attitudes as the learner interacts with information and the environment. Interaction is critical to creating a sense of presence and a sense of community for online learners, and to promoting transformational learning (Murphy & Cifuentes, 2001). Learners receive the learning materials through the technology, process the information, and then personalize and contextualize the information. In the transformation process, learners interact with the content, with other learners, and with instructors to test and confirm ideas and to apply what they learn. Garrison (1999) claims that the design of the educational experience includes the transactional nature of the relationship between instructor, learners, and content that is of significance to the learning experience.

Different kinds of interaction will promote learning at different levels. Figure 5 shows interactive strategies to promote higher-level

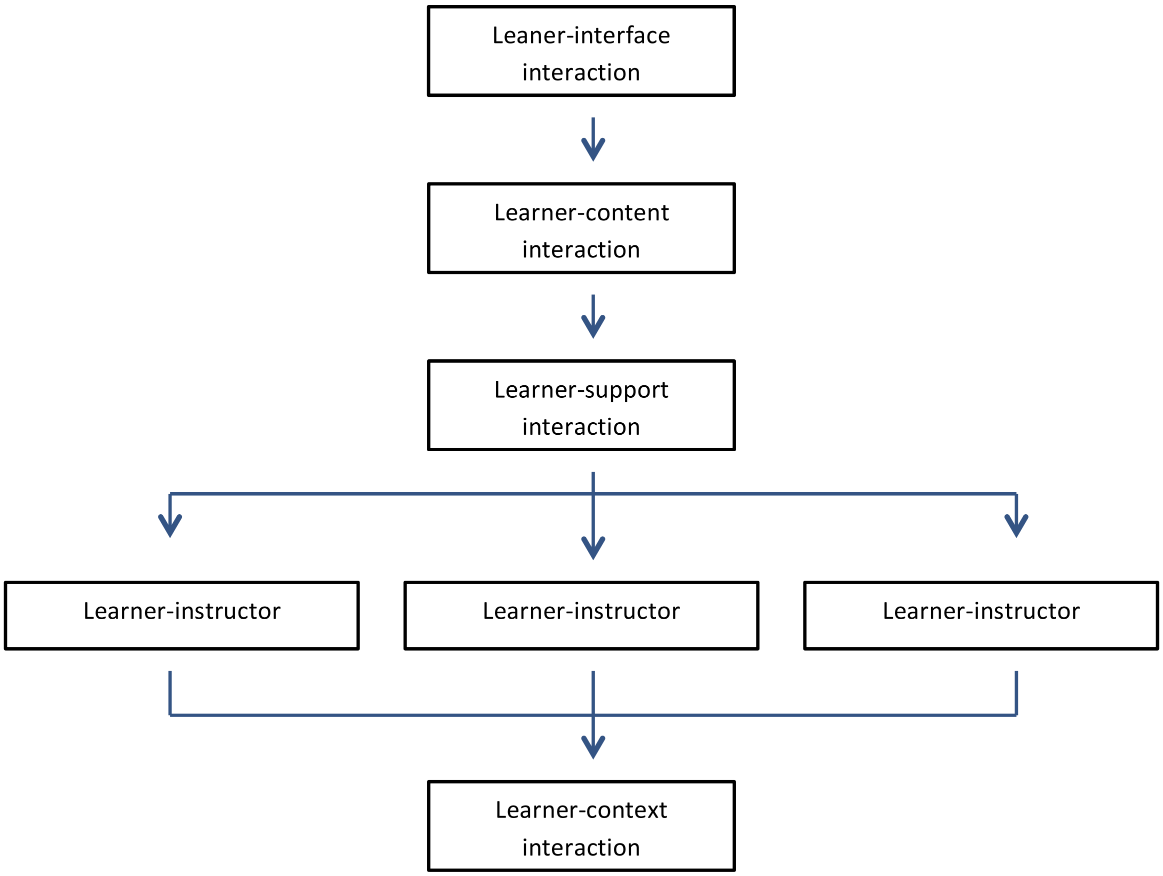


Figure 5. Levels of Interaction in online learning

learning (Berge, 1999; Gilbert & Moore, 1998; Schwier & Misanchuk,1993). Hirumi (2002) proposes a framework of interaction in online learning that consists of three levels. Level one is learner-self interaction, which occurs within learners to help monitor and regulate their own learning. Level two is learner-human and learner-non-human inter actions, where the learner interacts with human and non-human resources. Level three is learner-instruction interaction, which consists of activities to achieve a learning outcome. This chapter goes one step further and proposes interactions that go from lower-level to higher level interactions, based on behaviorist, cognitivist, and constructivist schools of learning.

At the lowest level of interaction, there must be learner-interface interaction to allow the learner to access and sense the information. The interface is where learners use their senses to register the information in sensory storage. In online learning, the interface is with the computer, to access the content and to interact with others. Once learners access the online materials, there must be learner-content interaction to process the information. Learners navigate through the content to access the components of the lesson, which could take the form of pre learning, learning, and post-learning activities.

These activities could access reusable learning objects from a repository to present to learners (McGreal, 2002; Wiley, 2002), or they could use content custom-created by the designer or instructor. Students should be given the ability to choose their own sequence of learning, or should be given one or more suggested sequences. As online learners interact with the content, they should be encouraged to apply, assess, analyze, synthesize, evaluate, and reflect on what they learn (Berge, 2002). During the learner-content interaction, learners process the information to transform it from short term to long-term memory. The higher the level of processing, the more associations are made in the learners' long-term memory, which results in higher-level learning.

As learners work through the content, they will find the need for learner support, which could take the form of learner-to-learner, learner to-instructor, instructor-to-learner, and learner-to-expert interactions (Moore, 1989; Rourke, Anderson, Garrison, & Archer, 2001; Thiessen,

2001). There should be strategies to promote learner-context interaction, to allow learners to apply what they learn in real life so that they can contextualize the information. Learner-context interaction allows learners to develop personal knowledge and construct personal meaning from the information.

CONNECTIVIST THEORY FOR ONLINE LEARNING

According to Siemens (2004), connectivist theory is for the digital age, where individuals learn and work in a networked environment. As a result, we do not have control over what we learn since others in the network continually change information, and that requires new learning, unlearning old information, and/or learning current information. Siemens proposes some guidelines for designing learning materials for the learner, based on connectivist theory. Below is an elaboration of these guidelines for the development of online learning materials.

• Because of the information explosion, learners should be allowed to explore and research current information. Learners of the future need to be autonomous and independent learners so that they can acquire current information to build a valid and accurate knowledge base. Appropriate use of the Internet is an ideal learning strategy in a networked world.

• Some information and procedures become obsolete because of changes in the field and innovation; learners must therefore be able to unlearn old information and mental models and learn current information and mental models. The information that is valid today may not be valid tomorrow.

• The rapid increase of information available from a variety of sources means that some information is not as important or genuine as other information. As a result, the learner must be able to identify important information from unimportant information.

• Learners must have the ability to recognize what knowledge is no longer valid so they can acquire the new knowledge for a discipline. This requires that learners keep up-to-date in the field and be active participants in the network of learning.

• Because of globalization, information is not location-specific, and with the increasing use of telecommunication, technologies experts and learners from around the world can share and review information. Learning and knowledge rests in a diversity of opinions. As a result, learners must be allowed to connect with others around the world to examine others' opinions and to share their thinking with the world. Mobile learning promises to help learners function in a networked world where they can learn at any time and from anywhere (Ally, 2005).

• The world is connected by telecommunication technology. Hence, information for learning should not be taken from one source but should be assembled from many sources to reflect the net worked world and the diversity of thinking. Learning should be delivered in a multi-channel system where different communication technologies are used to deliver the learning materials to facilitate optimal learning (Mukhopadhyay & Parhar, 2001).

• The field of computer systems is altering the learning process.

The intelligent agents that are being built into devices and appliances will affect how students learn and where they obtain their learning materials. For example, devices and appliances will have built-in learning materials. When learners interact with the equipment, the training will be provided to them. Or, if the learner makes a mistake while using the equipment, the system will detect the mistake and provide the correct information. Hence, what learners need to learn depends on the type of equipment they use and their prior knowledge.

• Because of the information explosion, learners of the future must be willing to acquire new knowledge on an ongoing basis. Online teaching strategies must give learners the opportunity to research and locate new information in a discipline so that they can keep up-to-date in the field. In addition to using the Internet to deliver flexibility, instruction must be designed for experiential and authentic learning (Schmidt & Werner, 2007).

• The Internet is expanding education into a global classroom, with learners, teachers, and experts from around the world. As a result, learners must network with other students and experts to make sure that they are continually learning and updating their knowledge.

• Because of innovation and our increasing use of technology, learning is becoming more multidisciplinary. Learners must be exposed to different fields so that they can see the connections between the information in the fields. For example, learning about learning theories requires that learners be exposed to what the research says in psychology and information technology. Siemens (2004) suggests that because of the networked society, globalization, and the constant changes to information and new information, educators need to look at new ways to design learning materials. He proposes a theory based on connectivism to prepare learners to function in the digital and networked age; however, further work needs to be done on how this theory can be used by educators to design and develop learning materials.

CONCLUSION

This chapter concludes by proposing a model, based on educational theory, that shows the important learning components that should be used when designing online materials. Neither placing information on the Web nor linking to other digital resources on the Web constitutes online instruction. Online instruction occurs when learners use the Web to go through the a sequence of instruction, to complete the learning activities, and to achieve learning outcomes and objectives (Ally, 2002; Ritchie & Hoffman, 1997). A variety of learning activities should be used to accommodate the different learning styles. Learners will choose the appropriate strategy to meet their learning needs. Refer to Figure 6 for key components that should be considered when designing online learning materials.

Learner Preparation

A variety of pre-learning activities can prepare learners for the details of the lesson, and to connect and motivate them to learn the online lesson. A rationale should be provided to inform learners of the importance of taking the online lesson and to show how it will benefit them. A concept map is provided to establish the existing cognitive structure, to incorporate the details of the online lesson, and to activate learners' existing structures to help them learn the details in the lesson. The lesson concept map also gives learners the big picture.

Learners should be informed of the learning outcomes of the lesson, so they know what is expected of them and will be able to gauge when they have achieved the lesson outcomes. An advance organizer should be provided to establish a structure, to organize the details in the online lesson, or to bridge between what learners already know and need to know. Learners must be told the prerequisite requirements so that they can check whether they are ready for the lesson. Providing the prerequisites to learners also activates the required cognitive structure to help them learn the materials.

A self-assessment should be provided at the start of the lesson to allow learners to check whether they already have the knowledge and skills taught in the online lesson. If learners think they have the knowledge and skills, they should be allowed to take that lesson's final test. The self-assessment also helps learners to organize the lesson materials and to recognize the important materials in the lesson. Once learners are prepared for the details of the lesson, they can go on to complete the online learning activities and to learn the details of the lesson.

Learner Activities

Online learning should include a variety of learning activities to help students achieve the lesson's learning outcome and to cater for their individual needs. Examples of learning activities include reading textual materials, listening to audio materials, and viewing visuals or video mate rials. Learners can conduct research on the Internet or link to online information and libraries to acquire further information. Having learners prepare a learning journal will allow them to reflect on what they have learned and provide the information with personal meaning. Appropriate application exercises should be embedded throughout the online lesson to establish the relevance of the materials. Practice activities, with feed back, should be included to allow learners to monitor how they are performing, so that they can adjust their learning method if necessary. To promote higher-level processing and to bring closure to the lesson, a summary should be provided, or learners should be required to gener ate a lesson summary. Opportunities should be provided for learners to transfer what they learned to real-life applications, so that they can be creative and go beyond what was presented in the online lesson.

Learner Interaction

As learners complete the learning activities, they will be involved with a variety of interactions. Learners need to interact with the interface to access the online materials. The interface should not overload learners, and should make it as easy as possible for learners to sense the informa tion, for transfer to sensory store and then into short-term memory for processing. Learners need to interact with the content to acquire the information needed and to form the knowledge base. There should be interaction between the learner and other learners, between the learner and the instructor, and between the learner and experts to collaborate, participate in shared cognition, form social networks, and establish social presence. Learners should be able to interact within their context to personalize information and construct their own meaning.

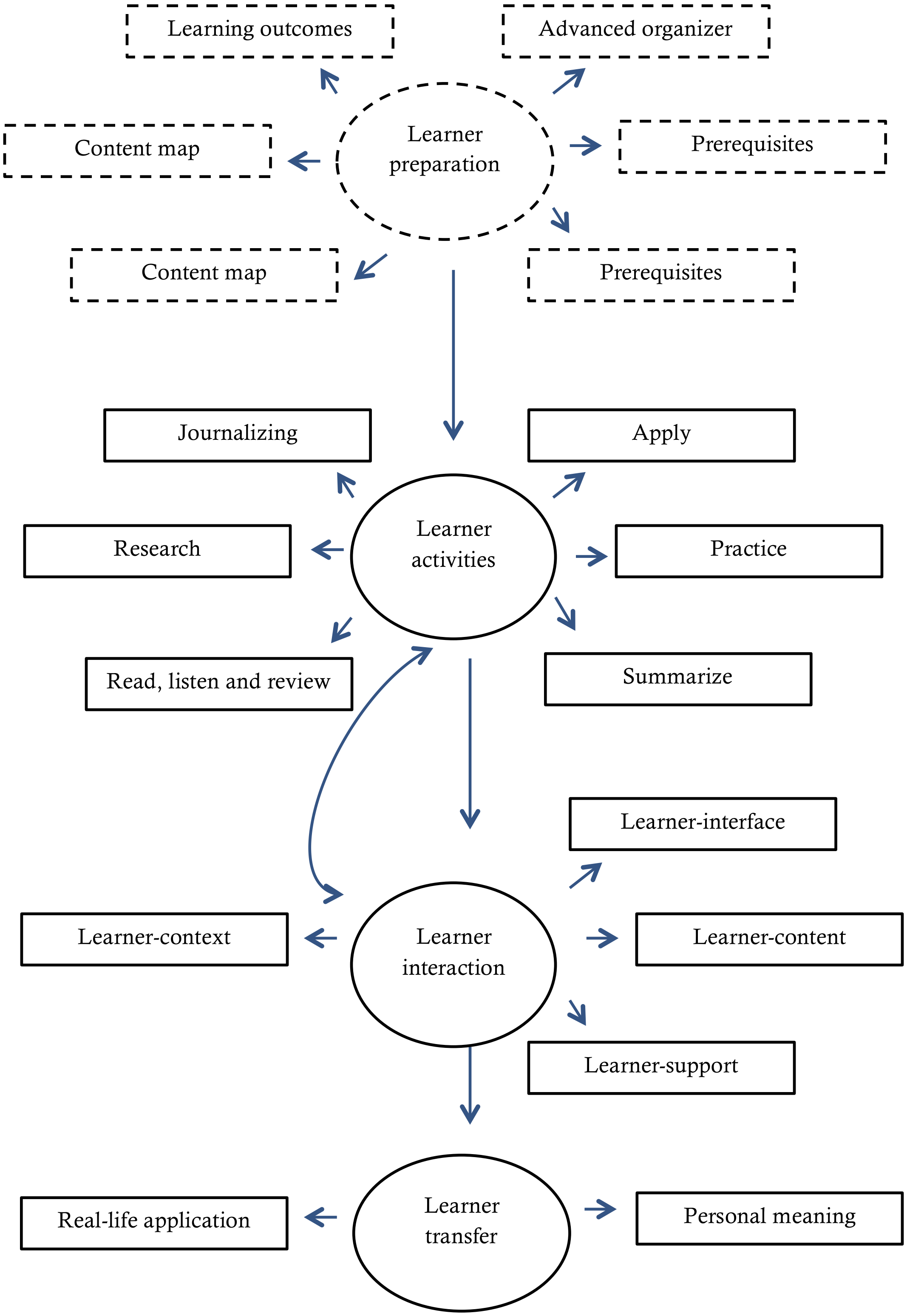


Figure 6. Components of effective online learning

LOOKING AHEAD

Behaviorist, cognitivist, and constructivist theories have contributed in different ways to the design of online materials, and they will continue to be used to develop learning materials for online learning. Behaviorist strategies can be used to teach the facts (what); cognitivist strategies, the principles and processes (how); and constructivist strategies to teach the real-life and personal applications and contextual learning. There is a shift toward constructive learning, in which learners are given the opportunity to construct their own meaning from the information pre sented during the online sessions. In addition to the existing learning theories, connectivism should be used to guide the development of online learning, since the other learning theories were developed before we became a networked world. Globalization has also affected what stu dents learn and how they learn. The use of learning objects to promote flexibility, and reuse of online materials to meet the needs of individual learners, will become more common in the future. Online learning materials will be designed in small coherent segments, so that they can be redesigned for different learners and different contexts. The integration of 3D interactive graphics and web technologies (Web3D) will allow educators to develop highly interactive and realistic learning environ ments to enhance online learning (Chittaro & Ranon, 2007). Finally, online learning will be increasingly diverse in response to different learning cultures, styles, and motivations.

REFERENCES

Ally, M. (2002, August). Designing and managing successful online distance education courses. Workshop presented at the 2002 *World Computer Congress*, Montreal, Canada.

Ally, M. (2005). Using learning theories to design instruction for mobile learning devices. In J. Attwell and C. Savill-Smith (Eds.), *Mobile learning anytime everywhere* (pp. 5–8). Proceedings of the Third World Conference on Mobile Learning, Rome.

Ally, M., and Fahy, P. (2002, August). Using students' learning styles to provide support in distance education. *Proceedings of the Eighteenth Annual Conference on Distance Teaching and Learning*, Madison, WI.

Ausubel, D. P. (1960). The use of advance organizers in the learning and retention of meaningful verbal material. *Journal of Educational Psychology*, 51, 267–272.

Ausubel, D. P. (1974). *Educational psychology: A cognitive view*. New York: Holt, Rinehart & Winston.

Berge, Z. L. (1999). Interaction in post-secondary web-based learning. *Educational Technology*, 39(1), 5–11.

Berge, Z. L. (2002). Active, interactive, and reflective learning. *The Quarterly Review of Distance Education*, 3(2), 181–190.

Beynon, M. (2007). Computing technology for learning – in need of a radical new conception. *Educational Technology & Society*, 10(1), 94–106.

Bonk, C. J., & Reynolds, T. H. (1997). Learner-centered web instruction for higher-order thinking, teamwork, and apprenticeship. In B. H. Khan (Ed.), *Web-based instruction* (pp. 167–178). Englewood Cliffs, NJ: Educational Technology Publications.

Carliner, S. (1999). *Overview of online learning*. Amherst, MA: Human Resource Development Press.

Cassidy, S. (2004). Learning Styles: An overview of theories, models, and measures. *Educational Psychology*, 24(4), 419–444.

Chittaro, L., & Ranon, R. (2007). Web3D technologies in learning, education, and training: Motivation, issues, and opportunities. *Computers and Education*, 49(1), 3–18.

Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research*, 53(4), 445–459.

Clark, R. E. (2001). A summary of disagreements with the 'mere vehicles' argument. In R. E. Clark (Ed.), *Learning from media: Arguments, analysis, and evidence* (pp. 125–136). Greenwich, CT: Information Age Publishing.

Cole, R. A. (2000). *Issues in web-based pedagogy: A critical primer.* Westport, CT: Greenwood Press.

Cooper, P. A. (1993). Paradigm shifts in designing instruction: From behaviorism to cognitivism to constructivism. *Educational Technology*, 33(5), 12–19.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A frame work for memory research. *Journal of Verbal Learning and Verbal Behavior*,11, 671–684.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, 104, 268–294.

Downes, S. (2006). *An introduction to connective knowledge*. Retrieved March 26, 2007, from http://www.downes.ca/post/33034

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170–198). New York: Simon & Schuster Macmillan.

Ertmer, P. A., & Newby, T. J. (1993). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, 6(4), 50–70.

Garrison, D. R. (1999). Will distance disappear in distance studies? A reaction. *Journal of Distance Education*, 13(2), 10–13.

Gilbert, L., & Moore, D .L. (1998). Building interactivity into web courses: Tools for social and instructional interaction. *Educational Technology*, 38(3), 29–35.

Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach* (4th ed.).White Plains, NY: Longman.

Heinich, R., Molenda, M., Russell, J. D., & Smaldino, S. E. (2002). *Instructional media and technologies for learning*. NJ: Pearson Education.

Hirumi, A. (2002). A framework for analyzing, designing, and sequenc ing planned e-learning interactions. *The Quarterly Review of Distance Education,* 3(2), 141–160.

Holley, C. D., Dansereau, D. F., McDonald, B. A., Garland, J. C., & Collins, K. W. (1979). Evaluation of a hierarchical mapping technique as an aid to prose processing. *Contemporary Educational Psychology*, 4, 227–237.

Hooper, S., & Hannafin, M. J. (1991). The effects of group composition on achievement, interaction, and learning efficiency during computer based cooperative instruction. *Educational Technology Research and Development*, 39(3), 27–40.

Hung, D., Looi,, C. K., & Koh, T. S. (2004). Situated cognition and com munities of practice: First-person 'lived experiences' vs. third-person perspectives. *Educational Technology & Society*, 7(4), 193–200.

Janicki, T., & Liegle, J. O. (2001). Development and evaluation of a framework for creating web-based learning modules: A pedagogical and systems approach. *Journal of Asynchronous Learning Networks*, 5(1). Retrieved June 10, 2007, from http://www.sloan-c.org/publications/ jaln/v5n1/pdf/v5n1_janicki.pdf

Johnson, D. W., & Johnson, R. T. (1996). Cooperation and the use of technology. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170–198). New York: Simon & Schuster Macmillan.

Kalat, J. W. (2007). *Introduction to psychology*. Pacific Grove, CA: Wadsworth Thompson Learning.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional design theories and instruction: An overview of their current status* (pp. 383–429). Hillsdale, NJ: Lawrence Erlbaum.

Keller, J. M., & Suzuki, K. (1988). Use of the ARCS motivation model in courseware design. In D. H. Jonassen (Ed.), *Instructional design for micro computer courseware* (pp. 401–434). Hillsdale, NJ: Lawrence Erlbaum.

Khan, B. (1997). Web-based instruction: What is it and why is it? In B. H. Khan (Ed.), *Web-based instruction* (pp. 5–18). Englewood Cliffs, NJ: Educational Technology Publications.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Kozma, R. B. (2001). Counterpoint theory of 'learning with media'. In R. E. Clark (Ed.), *Learning from media: Arguments, analysis, and evidence* (pp. 137–178). Greenwich, CT: Information Age Publishing Inc.

Malone, T. W. (1981). Towards a theory of intrinsically motivating instruction. *Cognitive Science*, 5(4), 333–369.

Mayer, R. E. (1979). Twenty years of research on advance organizers: Assimilation theory is still the best predictor of results. *Instructional Science*, 8(2), 133–167.

Mayer, R. E. (1998). Cognitive, meta-cognitive, and motivational aspects of problem solving. *Instructional Science*, 26(1–2), 49–63.

McGreal, R. (2002, February). *A primer on meta-data standards*. Session presented at Athabasca University.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. San Francisco, CA: Jossey-Bass.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63, 81–97.

Moore, M. G. (1989). Three types of interaction. *The American Journal of Distance Education*, 3(2), 1–6.

Mukhopadhyay, M., & Parhar, M. (2001). Instructional design in multi channel learning system. *British Journal of Education Technology*, 32(5), 543–556.

Murphy, K. L., & Cifuentes, L. (2001). Using web tools, collaborating, and learning online. *Distance Education*, 22(2), 285–305.

Myers, I. (1978). *Myers-Briggs type indicator*. Palo Alto, CA: Consulting Psychologists Press.

Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford: Oxford University Press.

Palloff, R. M., & Pratt, K. (1999). *Building learning communities in cyberspace*. San Francisco, CA: Jossey-Bass.

Pavlov, I. P. (1927). *Conditioned reflexes*. London: Clarendon Press.

Phillips, D. C. (2005). Theories of teaching and learning. *In A companion to the philosophy of Education*. Blackwell Synergy: Online Journals for Learning, Research, and Professional Practice. Retrieved March 26, 2007, from http://www.blackwellreference.com/subscriber/tocnode?id=g9781405140515_chunk_g978140514051519

Ring, G. & Mathieux, G. (2002, February). The key components of quality learning. Paper presented at the *ASTD Techknowledge 2002 Conference*, Las Vegas.

Ritchie, D. C., & Hoffman, B. (1997). Incorporating instructional design principles with the World Wide Web. In B. H. Khan (Ed.), *Web-based instruction* (pp. 135–138). Englewood Cliffs, NJ: Educational Technology Publications.

Rossett, A. (2002). Waking in the night and thinking about e-learning. In A. Rossett (Ed.), *The ASTD e-learning handbook* (pp. 3–18). New York: McGraw-Hill.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Assessing social presence in asynchronous text-based computer conferencing. *Journal of Distance Education*, 14(2). Retrieved June 10, 2007 from http://cade.athabascau.ca/vol14.2/rourke_et_al.html

Rovai, A. (2002). Building sense of community at a distance. *Interna tional Review of Research in Open and Distance Learning*, 3(1). Retrieved June 10, 2007, from http://www.irrodl.org/index .php/irrodl/article/ view/79/152

Schmidt, J. T., & Werner, C. H. (2007). Designing online instruction for success: Future oriented motivation and self-regulation. *Electronic Journal of e-Learning*, 5(1), 69–78.

Schramm, W. (1977). *Big media, little media*. Beverly Hills, CA: Sage.

Schwier, R. A., & Misanchuk, E. (1993). *Interactive multimedia instruction*. Englewood Cliffs, NJ: Educational Technology Publications.

Siemens, G. (2004). *A learning theory for the digital age*. Retrieved March 26, 2007 from http://www.elearnspace.org/Articles/connectivism.htm

Simmons, D. E. (2002). The forum report: E-learning adoption rates and barriers. In A. Rossett (Ed.), *The ASTD e-learning handbook* (pp. 19–23). New York: McGraw-Hill.

Skinner, B. F. (1974). *About behaviorism*. New York: Knopf.

Smith, P. L., & Ragan, T. J. (1999). *Instructional design*. New York: John Wiley & Sons.

Sternberg, R. J. (1998). Meta-cognition, abilities, and developing expertise: What makes an expert student? *Instructional Science*, 26(1-2), 127–140.

Stoyanova, N., & Kommers, P. (2002). Concept mapping as a medium of shared cognition in computer-supported collaborative problem solving. *Journal of Interactive Learning Research*, 13(1,2), 111–133.

Tapscott, D. (1998). *Growing up digital: The rise of the Net generation*. New York: McGraw-Hill.

Thiessen, J. (2001). *Faculty attitudes in delivering undergraduate distance education*. Unpublished master's thesis, Athabasca University, Athabasca, Alberta.

Thorndike, E. L. (1913). *Educational psychology: The psychology of learning*. New York: Teachers College Press.

Wiley, D. (2002). Learning objects need instructional design theory. In A. Rossett (Ed.), *The ASTD e-Learning Handbook* (pp. 115–126). New York: McGraw-Hill.

Wilson, B. G. (1997). Reflections on constructivism and instructional design. In C. R. Dills & A. J. Romiszowski (Eds.), *Instructional development paradigms* (pp. 63–80). Englewood Cliffs, NJ: Educational Tech nology Publications.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. *Review of Educational Research*, 47, 1–64.

Yorke, M., & Knight, P. (2004). Self-theories: Some implications for teach ing and learning in higher education. *Studies in Higher Education*, 29(1), 25–37.

ABOUT THE AUTHOR

Mohamed Ally is an associate professor for the Centre for Distance Education at Athabasca University. Dr. Ally teaches courses in distance education and is involved with research on improving design, develop ment, delivery, and support in distance education.